CURRENT LITERATURE

BOOK REVIEWS

Soil acidity

The injury to vegetation by smoke from factories and smelters is well known. Much has been written on the subject, and considerable experimental work is now under way in various parts of the world. WIELER[1] has published recently an account of one series of experiments, begun in 1905, dealing with plant growth and the lack of lime in the soil. In this account he defends the thesis that smoke and smelter fumes are injurious to plants, not because of their direct effect on the leaves, but because the acid-forming substances they contain are absorbed in the soil and there neutralize the lime so necessary to plant growth. He argues also that there is an injurious effect on the micro-organisms of the soil.

The region studied in greatest detail is a part of the Innerste Valley where considerable damage has been done by fumes from the Frankenscharrn smelters. The forest here has been driven back to considerable distances, amounting to 3.5 kilometers in some directions. Even where trees were still standing, they showed by their stunted appearance and yellow leaves or needles the injurious effects of conditions surrounding them. Certain slopes bore only heath, low shrubs, and stunted trees, others only grasses, and still others no vegetation at all. Injury was greatest close to the smelter and decreased as the distance from the smelter increased.

On the three kinds of slopes just described, experimental plots were laid out at distances of 0.5 to 1.5 kilometers from the source of the fumes. To these plots additions were made of lime, lime and ammonium hyperphosphate, and ammonium hyperphosphate alone. This substance was added on the supposition that the soil was poor in nitrogen. No striking results were obtained by its use, however, and it need not be considered further. Slaked lime was applied in finely ground form in quantities varying from 50 to 100 kilograms per hectare. Untreated plots were studied as checks in all cases.

Plantings were made of *Picea excelsa*, *Pinus sylvestris*, *P. montana*, *Quercus robur*, *Fagus sylvatica*, *Betula alba*, *Vicia villosa*, and *V. sativa*. It was found in all cases that plants on unlimed plots grew much less rapidly and appeared less healthy than those on limed plots. Conifers and legumes either did not grow at all without lime, or only poorly. Oak, beech, and birch proved to be less rigorous in their requirements, but did better on treated plots. Plants from seed gave poorer results than those transplanted from the nursery.

[1] WIELER, A., Pflanzenwachstun und Kalkmangel im Boden. 8vo. pp. vii+235. *figs.* 43. 1912.

Mention was made above of the yellow color of leaves on plants in affected areas. This condition is generally considered to be due to a lack of nitrogen in the soil; this in turn is a consequence of poor development of the bacterial flora. That such conditions prevail in the soil of these denuded or partly denuded hillsides was shown by the fact that in unlimed plots very few bacterial nodules were found on the roots of legumes. Development of such nodules was practically normal, however, where lime had been added.

Root systems were found to be small on unlimed soil. Both primary and secondary roots were short and there was only a small amount of branching. As a consequence, the whole root system formed a knob or lump which came in contact with very little soil and furnished poor anchorage for the plant. There was thus more danger of injury from drought and from strong winds. Results confirming those already described were obtained by liming soils in other localities, hence they need not be discussed here.

The author's idea of the causes of the deliming of soils and consequent inhibition of plant growth has already been stated. In a discussion of his results he considers these causes at some length. He finds, in the first place, that all the untreated soils really are poor in lime. Near the smelter this substance was present to the extent of 0.012 per cent; in experimental plots along the sides of the valley it varied from 0.017 per cent to 0.045 per cent; under a spruce stand it was 0.038 per cent.

Further investigation of these soils brought out the surprising fact that they were acid in reaction, instead of alkaline or neutral, as might have been supposed. It is known of course that wet moor soils are acid, but this has been found by BAUMAN and SULLY to be due, not to the presence of free humic acids, but to the power of certain substances in these soils to decompose salts by forcing acids out of combination and by absorbing the bases with which they were combined. These authors showed further that this reaction is brought about by the "absorptively unsaturated" condition of the cell walls of sphagnum. The acid character of moor soils depends, therefore, on the fact that the material from which they arise is already acid. But there is good reason, says WIELER, for thinking that dry peaty soils originate in the same way as do those of sphagnum bogs; that is, the plant remains in the former case are acid, just as they were in the latter. This deduction was amply confirmed by tests on living leaves and needles, the same organs dead and still remaining on the tree, or covering the ground beneath these trees.

That the acids set free in the manner indicated above are not neutralized or decomposed depends finally on the failure of microorganisms to do their usual work. From undecomposed organic remains acids are being washed out continually by rains. As soon as bacterial and fungal action begins these acids are broken up into harmless substances. In soils, however, where the acid content is steadily increasing, as in the region around the Frankenscharrn smelter, the bases, most important of which is lime, are neutralized. As a consequence, microorganisms do not thrive, and plant fragments and the soil

itself remain acid. And not only so, but the important process of nitrification, carried on by bacteria whose activity is closely connected with the amount of lime available, is seriously retarded. Leaves become yellow and there is a general nitrogen starvation of all vegetation.

It developed during the course of the investigation that the addition of lime to such soils, even though it improved materially the conditions for plant growth, reduced the acidity only one-third. This result, taken together with the fact that an acid soil need not contain free acid, and the further fact that forest trees do grow on acid soils, makes it plain, in the opinion of the author, that lime is valuable, not because it neutralizes acids, but because it furnishes a substance indispensable to normal plant growth. The conclusion thus reached points definitely to the use of lime as a means of combating smoke injury to vegetation and of rendering denuded areas again able to support plant life.

A supplementary investigation of the effect of metallic poisons in the soil showed that the sensitiveness of plants to these poisons varies greatly. It was found possible to arrange a complete series, leading from those which were seriously affected to those whose growth was definitely improved.—D. H. ROSE.

The living plant

It is with some interest that plant physiologists and ecologists will read GANONG'S[1] new book on *The living plant*. It is the first attempt in English to bring, in a comprehensive way, the main findings of these subjects within reach of the layman. The aims of the volume are well stated in the first paragraph of the preface: "It is not designed as a digest of our present scientific knowledge of plant physiology for the use of experts in the subject, but, in conformity with the aim of the series of which it is a part, it seeks to present to all who have interest to learn an accurate and vivid conception of the principal things in plant life. I was once myself such a learner, and I have tried to write such a book as I would then have delighted to read. It is, in a word, an attempt at that literature of interpretation which was forshadowed by FRANCIS BACON in the fine passage that stands on its dedicatory page."

Aside from the general interest in plants, we have at present a rapidly growing interest in agriculture. This makes the issue of the present clear statement of the principles of plant production especially timely. In this work the author has lived up to his high reputation as a teacher. One is surprised at the clearness and vividness with which he sets forth the main features of plant activity. Aside from presenting the main findings of the subject, the author gives a clear insight into the scientific method in action, for repeatedly he shows the processes by which the conclusions have been reached. He likewise makes clear the large cosmic relations of the subject.

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[1] GANONG, WILLIAM F., The living plant. 8vo. pp. xii+148. *figs. 178*. New York: Henry Holt & Co. 1913.